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ABSTRACT

This paper reports findings from the first 2 years of a longitudinal study of school effectiveness in Western Australia called the Western Australian School Effectiveness Study (WASES). Creemer's multilevel model of educational effectiveness was used to guide the selection of variables for analysis. Data on the school environment, the classroom learning environment, student background variables, teacher and student self-concept, teacher morale, and science and mathematics achievement were collected twice for each of 849 students in 4 urban, 10 rural, and 7 remote high schools. School effectiveness was defined in two ways: in terms of academic achievement and in terms of teacher morale as a reflection of educational environment. Most of the variation in science and mathematics achievement was explained by student-level variables, particularly socioeconomic status, gender, aboriginality, English-speaking background, and academic self-concept. Virtually no variance in achievement was explained by school-level variables, although some differences among classes may be attributable to differences in teacher characteristics, peer effects, or classroom environment. There were no rural-urban differences in student achievement after controlling for student characteristics and previous achievement. When school effectiveness was defined in terms of teacher morale, effective schools had teachers with higher self-concept, higher levels of teacher supportiveness of students, and more clearly defined mission. (Contains 96 references and 18 data tables and figures.) (SV)

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Characteristics of Effective Rural Schools: A Longitudinal Study of Western Australian Rural High School Students

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Characteristics of Effective Rural Schools: A Longitudinal Study of Western Australian Rural High School Students

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INTRODUCTION

The purpose of this study was to identify the characteristics of effective rural high schools by investigating factors influencing science and mathematics achievement. This paper reports findings from the first two years of a longitudinal study undertaken in 21 urban and rural schools in Western Australia, called the ***Western Australian School Effectiveness Study (WASES)***. A multilevel analytical model is used to demonstrate that most variability in student achievement is at the classroom and student level, with negligible amounts at the school level. Upon further analysis of the residuals, this paper demonstrates that teacher effects are substantial and warrant further investigation. This study suggests that effective schools are characterised by high staff morale and self-esteem and students with high self-esteem.

REVIEW OF SCHOOL EFFECTIVENESS RESEARCH

In early research on school effectiveness, there was considerable emphasis on the ability and family background of the student in determining academic performance. The Coleman Report (Coleman et al., 1966, p. 296) estimated that the school influence on student achievement was about 10 to 20 percent of the total variance, yet the methodology used by Coleman had not accounted for the hierarchical nature of students nested within schools. Coleman's findings were repeated in further large-scale studies (Jencks et al., 1972, 1979; Hauser, Sewell & Alwin, 1976), which suggested that (1) school level variables, such as physical resources, account for small amounts of variability in student achievement and (2) student characteristics, such as socioeconomic status and home background, should be used to adjust student achievement in statistical analysis of large-scale studies.

In Britain, research into schools became prominent during the 1980s with Fogelman's findings that the amount of schooling received by students was directly related to their academic achievement (1978, 1983). While early British researchers analysed the effects of academic and social backgrounds of students, there was some doubt about whether control for differences in student intake was adequate (Reynolds, 1976; Reynolds & Sullivan, 1979; Rutter et al., 1979). Reynolds reported large school level differences in attendance rates, even when students came from similar social and economic backgrounds. More recent studies, which included student information prior to school entry and better analytic techniques, reported substantial variations between schools (Mortimore et al., 1988; Smith & Tomlinson, 1989; Nuttall et al., 1989). The improvement of analytical techniques more adequately addressed the hierarchical nature of the data, that is, the variability between schools and within schools was separated (Bryk & Raudenbush, 1986; Goldstein, 1984, 1987).

While early British research by Reynolds (1982) and Rutter and colleagues (1979) indicated that schools affected students equally, later studies by Aitkin and Longford (1986) found significant differences in school effects for students from different socioeconomic backgrounds. Further, Cuttance (1992, pp. 78-79) reported that achievement was significantly greater for students from more affluent home backgrounds, when compared with students from poorer homes. In this British study, Cuttance showed that school intake differences account for a large proportion of the variation in unadjusted variation in student achievement. Finally, Cuttance asserted that any analyses of the effectiveness of schools need to adjust for the social background and prior attainment of students.

The examination of social and gender differences in United States schools has led researchers such as Levine (1992) to recommend that multiple measures of students' social and economic background be used to control

for social class influences on achievement. Levine et al. (1979) found that the frequently used US indicator, students' subsidised lunch status, was not useful due to highly variable reporting by principals. Levine also urged that schools be examined for their effectiveness in equalising the academic achievement of minorities and disadvantaged groups. The importance of examining the equity of the school, as well as the school's effectiveness, was advocated by US researchers who found that a school could be identified as highly effective, yet have lower class and minority students with poor academic performance (Brookover, 1985; Shoemaker, 1984; Lezotte, 1986).

The importance of the school and classroom environment in enhancing learning has been investigated by Fraser (1986, 1991), who found strong links between student outcomes and their educational environments. Fraser and Tobin combined qualitative and quantitative methodologies in their study of exemplary teachers and found the classroom learning environment was decisive in enhancing student learning in science (Fraser & Tobin, 1989; Tobin & Fraser, 1987). In addition, studies into factors associated with educational productivity found nine consistent factors: student ability, student development, student motivation, instructional time, instructional quality, home environment, classroom environment, peer groups and television viewing (Fraser, Walberg, Welch & Hattie, 1987).

CONTEXT STUDY IN SCHOOL EFFECTIVENESS RESEARCH

Educational researchers who were challenged by the Coleman report's conclusion that schools don't matter, set about to investigate schools that served low-SES students who performed well on standardised tests (Brookover et al., 1979; Brookover & Lezotte, 1979; Edmonds, 1979b; Glenn, 1981; Klitgaard & Hall, 1974; Venezky & Winfield, 1979). As the research developed on effective schools for the "urban poor", Edmonds repudiated Coleman and Jencks:

> Repudiation of the social science notion that family background is the principal cause of pupil acquisition of basic skills is probably prerequisite to successful reform of public schools.
>
> (Edmonds, 1979a, p. 23)

However, in a new phase of school effects research, sampling procedures were improved and the characteristics of effective schooling for students from a variety of contexts were questioned (Wimpelberg, Teddlie & Stringfield, 1989). These researchers began to ask what makes an effective school for the disadvantaged groups in our community. Further, Levine and Lezotte (1990) concluded that three types of school contexts should be studied in school effects research:

- Student body SES (socioeconomic status of the aggregated student population)
- Grade level of schooling
- Urbanity (rural versus urban)

Stringfield and Teddlie's ten year longitudinal study of effective schools in Louisiana cumulated in significant findings that there were six types of differentially effective schools (Stringfield & Teddlie, 1991, 1993). These researchers found that students in more effective schools had higher future educational expectations than those from less effective schools. For these students, they felt less academic futility and perceived greater teacher push than did those students from less effective schools. There was a more positive educational climate for students from more effective schools.

While some effective-school characteristics were found regardless of the school SES, such as clear academic mission, orderly environment, high academic engagement and frequent monitoring of student's progress, there were a number of differences in characteristics of effectiveness between middle- and low-SES schools (p. 36). A difference in future educational expectations by teachers in the two types of schools was associated with effectiveness. They found that teachers in effective low-SES schools held high present, but more modest future, expectations for their students.

Of significant importance was the differences in effectiveness of schools depending upon the urbanity context of the school. Stringfield and Teddlie summarised 16 characteristics of differentiation between urban, suburban and rural elementary schools (1993, pp. 158-162). For example, 'in small towns, an effective rural principal can help the school to become the focal point of the community and garner additional resources along the way'.

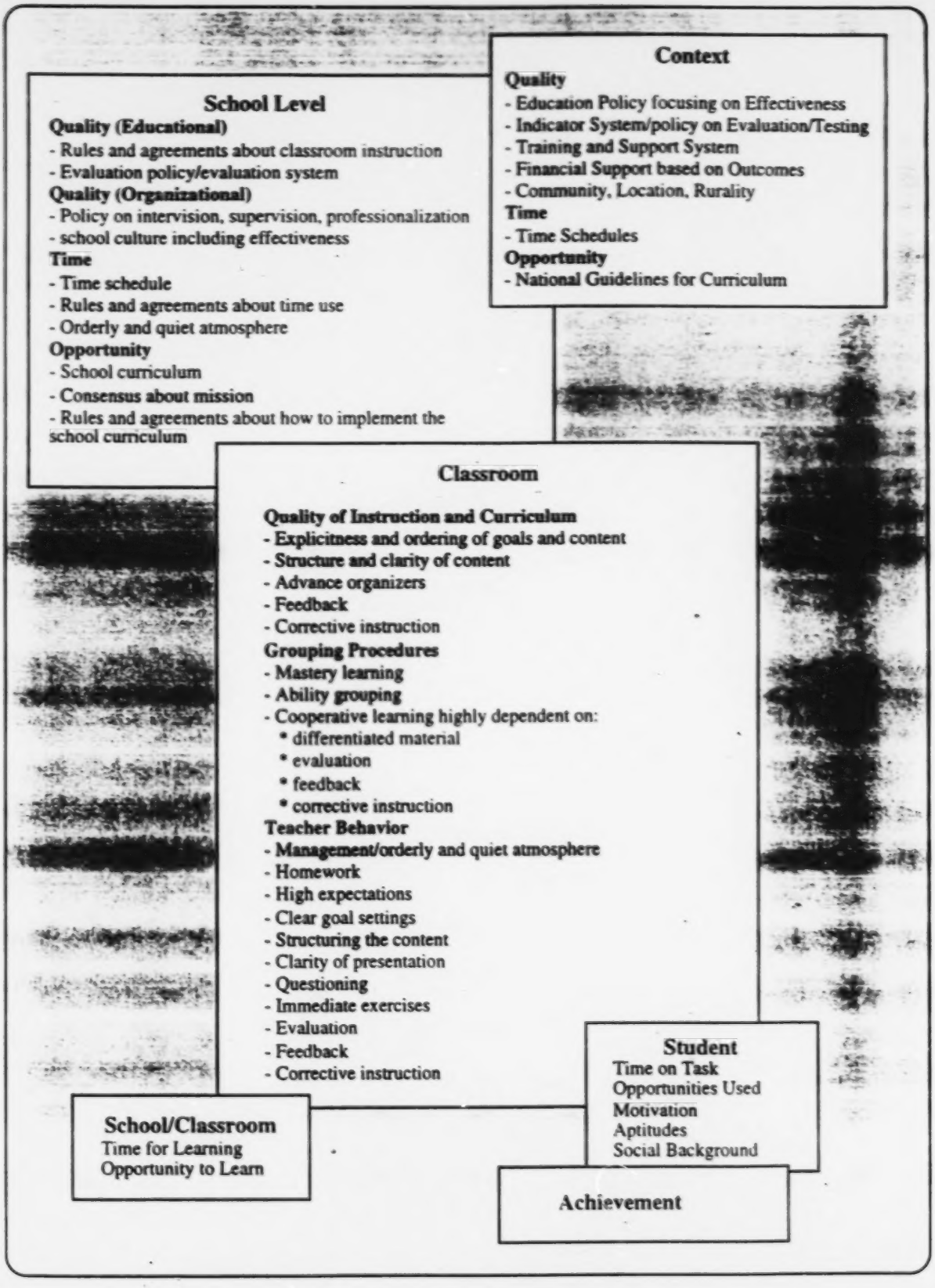

Figure 1. Creemers' Model of Educational Effectiveness (Creemers, 1994, p. 119)

CONCEPTUAL FRAMEWORK AND RESEARCH QUESTIONS

A conceptual framework for educational effectiveness described by Creemers (1994, p. 119) is summarized in Figure 1, proposed a multi-level model of schooling which incorporates three organisational levels: the student, the classroom and the school. These three levels were investigated using multilevel modelling of a large-scale, longitudinal survey data as suggested Stringfield and Teddlie's contextually sensitive research studies (1993).

Creemers based this model on Carroll's model for school learning (1963, 1989), which states that the degree of student mastery is a function of the ratio of the amount of time students actually spend on learning tasks to the total amount of time they need. The time spent on learning is equal to the smallest of three variables:

- Opportunity To Learn
- Perseverance
- Aptitude

Unfortunately, Carroll's model tends to be an instructional model, rather than a learning model (Creemers, 1994, p. 25) and Creemers unpacks a more comprehensive model (see Figure 1) which includes:

- Student Level – Time on task; Opportunities used; Motivation; Aptitude; Social background
- Classroom Level – Quality of instruction; Grouping procedures; Teacher behaviour
- School Level – Educational quality; Organizational quality; Time management; Opportunity
- Context Level – Quality of policies, national guidelines, national testing, time schedules, curriculum

In this study, this multilevel model of educational effectiveness was used to guide the selection of variables for analysis. At the context level, comparisons of rural and urban schools were made. The school environment and classroom learning environment were measured for each student, along with student background variables, self-concept (teacher and student), teacher morale and science and mathematics achievement at two time points for each student (1996 and 1997).

There are two characteristics of effective schools which are discussed in this study. Firstly, student achievement in science and mathematics is modeled after accounting for student background and previous achievement. This characteristic presupposes that an effective school adds more value to a student, when compared with an ineffective school. Secondly, average teacher morale in the school was compared. This characteristic is predicated upon the belief that effectiveness is not related to student achievement, but rather that an effective school is a happy, pleasant environment with contented and satisfied students and teachers.

RESEARCH DESIGN

This research study, the Western Australian School Effectiveness Study [WASES] involves three phases (Table 1). In the *First Phase*, the survey instruments were developed and piloted in two schools in 1995 (Young, 1996; Young & Fisher, 1996a, 1996b, 1996c).

In the *Second Phase*, a three year longitudinal survey was commenced in 28 West Australian high schools. Both Government, Catholic and Independent secondary schools were surveyed. The purpose of this survey was to evaluate the school and classroom climate and characteristics of effective schools in differential contexts. Because the growth model is particularly useful for measuring change over time in student outcomes, while controlling for other influencing variables which may also change over time, the same students at the same schools will be surveyed over a period of three years (1996 to 1998). This phase will be called WASES-II in 1996, WASES-III in 1997 and WASES-IV in 1998 and is being funded in part by the Australian Research Council. The common longitudinal cohort was a smaller sample of 849 students in 21 high schools. The reduction in size was due to many factors such as loss of students due to mobility, lack of teacher cooperation, insufficient data supplied in both years and lack of tracking forms by the school. Results from the WASES 1996 data collection may be found in Young (1997a, 1997b, 1997c) and in Young (in press).

Finally, in the *Third Phase*, a case study approach will be used to examine some exceptionally effective schools in the rural and urban locations of Western Australia (1997-99). Case studies commenced in 1997 and selected from some outlier schools based on statistical data from WASES-II and WASES-III. While some interesting data has been collected and observations made at some of the more effective rural schools, further case study research is planned in an intensive study in 1999 continent upon further funding from the Australian Research Council.

Table 1. Longitudinal sampling frame.

Phases of Study	Year of Study	Grade of Sample	Longitudinal Cohort of Schools	Longitudinal Cohort of Students
[WASES-I]	1996	Years 8, 9, 10	21 Secondary Schools	849
[WASES-II]	1997	Years 9, 10, 11	21 Secondary Schools	849
[WASES-III]	1998	Years 10, 11, 12	21 Secondary Schools	849
[WASES-IV]	1999	Case Studies of Outliers	4–8 Rural and Urban Schools/Classrooms - Effective and Ineffective	

* Note: only 849 students will be continuing in the 1998 study due to loss over time (students not in both 1996 and 1997) and cleaning of data throughout the study (students not providing complete questionnaire or test data.

Assessing the School Environment

International research efforts involving the conceptualisation, assessment and investigation of perceptions of psychosocial aspects of educational environments have established educational environment as an important field of study (Fraser, 1994; Fraser & Walberg, 1991). One of the originators of this line of research, Moos (1974), found that the same three general categories can be used in conceptualising the individual dimensions characterising diverse psychosocial environments. This finding emerged from Moos's work in a variety of environments including hospital wards, school classrooms, prisons, military companies, university residences and work milieus. The three basic types of dimensions are: Relationship Dimensions (e.g., peer support, involvement) which identify the nature and intensity of personal relationships within the environment, and assess the extent to which people are involved in the environment and the extent to which they support and help each other; Personal Development Dimensions (e.g., professional interest) which assesses the basic directions along which personal growth and self-enhancement tend to occur; and System Maintenance and System Change Dimensions (e.g., innovation, work pressure) which involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change.

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Recent classroom environment research has focused on science laboratory classroom environments (McRobbie &, Fraser, 1993), constructivist classroom environments (Taylor, Dawson & Fraser, 1995) and computer-assisted instruction classrooms (Teh & Fraser, 1995), while other studies have focused on the school environment (Fisher, Fraser & Wubbels, 1993). However, a careful review of the potential strengths and problems associated with existing school environment instruments led to the development of a new school environment instrument named the *School Level Environment Questionnaire* (SLEQ) (Fisher & Fraser, 1990), which measures teachers' perceptions of psychosocial dimensions of the school environment. This instrument consists of seven scales, with two measuring Relationship Dimensions (Student Support, Affiliation), one measuring the Personal Development Dimension (Professional Interest) and five measuring System Maintenance and System Change Dimensions (Staff Freedom, Participatory Decision Making, Innovation, Resource Adequacy and Work Pressure).

Table 2. Description of scales in SLEQ and their classification according to Moos' scheme.

Scale Name	Description of Scale	Sample Item	Moos's Category
Student Support	There is good rapport between teachers and students and students behave in a responsible self-disciplined manner.	There are many disruptive, difficult students in the school. (–)	Relationship
Affiliation	Teachers can obtain assistance, advice and encouragement and are made to feel accepted by colleagues.	I feel that I could rely on my colleagues for assistance if I should need it. (+)	Relationship
Professional Interest	Teachers discuss professional matters, show interest in their work and seek further professional development.	Teachers frequently discuss teaching methods and strategies with each other. (+)	Personal Development
Mission Consensus	Consensus exists within the staff about the goals	Teachers agree on the school's overall goals. (+)	System Maintenance and System Change
Empowerment	Teachers are empowered and encouraged to be involved in decision making processes.	Decisions about the running of this school are usually made by the principal or a small group of teachers. (–)	System Maintenance and System Change
Innovation	The school is in favour of planned change and experimentation, and fosters classroom openness and individualisation.	Teachers are encouraged to be innovative in this school (+)	System Maintenance and System Change
Resource Adequacy	Support personnel, facilities, finance, equipment and resources are suitable and adequate.	The supply of equipment and resources is inadequate. (–)	System Maintenance and System Change
Work Pressure	The extent to which work pressures dominates school environment.	Teachers have to work long hours to keep up with the workload. (+)	System Maintenance and System Change

Items designated (+) are scored by allocating 5, 4, 3, 2, 1, respectively, for the responses Strongly Agree, Agree, Not Sure, Disagree, Strongly Disagree. Items designated (–) are scored in the reverse manner. Omitted or invalid responses are given a score of 3.

Fisher, Fraser and Wubbels (1993) have reported validation data for the SLEQ for a number of samples including one study of 46 teachers in seven Australian schools. The validation data include information about each scale's internal consistency (Cronbach alpha reliability), discriminate validity (mean correlation of a scale with the other seven scales) and the ability of the instrument to differentiate between the perceptions of teachers in different schools. The alpha coefficients for different SLEQ scales ranged from 0.65 to 0.92 suggesting that each SLEQ scale displays satisfactory internal consistency for a scale composed of only seven items.

The SLEQ consists of 56 items, with each of the eight scales being assessed by seven items. Each item is scored on a five-point scale with the responses of Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree. Table 2 describes the nature of the SLEQ by providing a scale description and sample item for each scale and shows each scale's classification according to Moos' scheme. As well, Table 2 provides information about the method and direction of scoring of SLEQ items.

For this study, all of the above mentioned SLEQ scales were used, however construction of the scales involved weights which were obtained via Confirmatory Factor Analysis.

Assessing the Classroom Learning Environment

That classes and schools differ in terms of their learning environments, which in turn influence student achievement has been demonstrated by Hattie (1987) who showed that 20% of students in desirable climates are better off than students in average classrooms. In the last 25 years there have been instruments developed for a range of classroom contexts, such as individualised classrooms (Fraser, 1990) and constructivist classrooms (Taylor, Dawson & Fraser, 1995). These instruments have been employed in a range of studies, with different instruments and scales used in particular studies. Recently, Fraser, Fisher and McRobbie (1996) began the development of a new learning environment instrument which incorporates scales that have been shown in previous studies to be significant predictors of outcomes (Fraser, 1994) and additional scales to accommodate recent developments and concerns in classroom learning, such as equity issues and the promotion of understanding rather than rote memorisation. The first version of the new instrument contained the following 9 scales, each scale containing 10 items: *Student Cohesiveness, Teacher Support, Involvement, Autonomy/Independence, Investigation, Task Orientation, Cooperation, Equity and Understanding.* The new instrument employed the same five-point Likert response scale (Almost Never, Seldom, Sometimes, Often, Almost Always) as used in some previous instruments.

For the purposes of this study, we used 6 of these scales in the student questionnaire, that is, *Student Cohesiveness, Teacher Support, Involvement, Autonomy/Independence, Task Orientation* and *Cooperation* (see Table 3). The construction of the scales involved weights which were obtained via Confirmatory Factor Analysis and the method is described in a latter section of this paper.

Table 3. Description of scales in the CLES and example items

CLASSROOM LEARNING ENVIRONMENT	
SCALE	EXAMPLE ITEM
Student cohesiveness	Friendships are made among students in this class.
Teacher support	The teacher goes out of his/her way to help students.
Student involvement	Students talk with each other about how to solve problems.
Independence	I have a say in deciding what activities I do.
Task orientation	Class assignments are clear so everyone knows what to do.
Cooperation	Students share their books and other resources with each other when doing assignments.

Student and Teacher Self-concept

> "That self-concept is related to achievement presupposes that certain classroom environments enhance both aspects." (Hattie, 1992, p. 197).

In previous research about self-concept, the multidimensional nature has been well documented (Byrne, 1984; Hattie, 1992; Marsh, 1990, 1993; Marsh & Shavelson, 1985). The academic components of the model have been the focus of attention in relationship to external constructs such as academic achievement. We included two components of the Marsh Self Description Questionnaire (SDQII) designed to measure adolescent self-concepts (Marsh, 1992).

Included in this study, were two measures of Self-Concept, namely, General Self-Concept and Academic Self-Concept each comprised of 10 items. Examples of items from these two measures are presented in Table 4a. The General Self-Concept scale describes the student's feelings about himself/herself. There are both negative and positive statements related to success and failure in life. The Academic Self-Concept scale measures the student's perceptions about their academic ability and potential to be a success at school. The construction of the Self-Concept scales involved the use of Confirmatory Factor Analysis and the method is described in a latter section of this paper.

Table 4a. Description of some items from the student Self-Concept scales.

Student Self-Concept Scale Items		
Scale	Example Items	No. Items
General Self-Concept	Overall, I have a lot to be proud of.	10
	Overall, I am no good.	
	Most things I do, I do well.	
	Nothing I do ever seems to turn out right.	
	Overall, most things I do turn out well.	
Academic Self-Concept	People come to me for help in most school subjects.	10
	I'm too stupid at school to get into a good university.	
	If I work really hard I could be one of the best students in my school year.	
	I get bad marks in most school subjects.	
	I learn things quickly in most school subjects.	

Similarly, teachers were asked about their general self-concept and academic self-concept using similar items to those in Table 4a. Teachers' perceptions of their academic ability is often called Teacher Efficacy. Teacher Efficacy developed out of Bandura's theory of self-efficacy (1977; 1993). Bandura proposed that a person was motivated by two forces: outcome expectations and efficacy expectations. Outcome expectations refer to a person's belief that their behaviour will result in a specific outcome. Efficacy expectations refer to the person's belief that he/she is capable of demonstrating the behaviours necessary to achieve the outcome.

> Teacher Efficacy, the belief that one can bring about desired outcomes in one's students, has been found to discriminate teachers in less effective schools from those in more effective schools. (Soodak & Podell, 1996)

Teacher Morale

A scale from the School Organizational Health Questionnaire (Hart, Conn & Carter, 1992) was used in the teacher questionnaire to measure Teacher Morale in the school and the items used in this scale are found in Table 4b.

Table 4b. Description of some items from the Teacher Morale scales.

Teacher Morale Items
There is a good team spirit in this school.
There is a lot of energy in this school.
The morale in this school is high.
Teachers go about their work with enthusiasm.
Teachers take pride in this school.

Science and mathematics achievement

For the purposes of this study, a relatively simple multiple-choice test of mathematics and science was employed in both 1996 and 1997. This test had already been validated internationally for use in the Third International Mathematics and Science Study (TIMSS) for 13-14 year old students. The TIMSS tested and questioned students, teachers and schools in 200 schools throughout Australia and in 50 other countries. The results of the TIMSS are available from the Australian Council for Educational Research (Lokan, Ford & Greenwood, 1996) and international findings and reports may be viewed at the World Wide Web site:

Http://wwwcsteep.bc.edu/timss

Three different rotated forms of the possible eight tests available were used and the open-ended/free response part of the test was not used due to time constraints. There were 18 mathematics test items and 18 science test items which had to be completed in 45 minutes. There was reading time and example test items provided prior to the commencement of the test. Analysis of the test items involved a procedure called Rasch Modelling which scores the test items and then estimates the student's ability on that test item as a function of the difficulty of the test item and the student responses to other test items. The final science and mathematics achievement measures were constructed using the Rasch Model.

THE SAMPLE

Western Australian schools are located in a variety of locations, which have previously been categorized into three groups in other analyses (Tomlinson, 1994; Young, 1994a, 1994b): metropolitan Perth, rural and remote. Unfortunately, these three categories did not account for rural cities and other types of rural locations (similarly for the remote category). Subsequently, these categories have been expanded by the Department of Primary Industries and Energy and the Australian Bureau of Statistics (DPIE, 1994) into seven categories, five of which were then used in this study (Table 5). The five categories were Metropolitan (Capital City), Small Rural Centres, Other Rural Areas, Remote Centres and Other Remote Areas and these were incorporated into this study. In Western Australia, only these five categories are applicable.

There were 849 students in the sample of students from 21 schools in 1997, who were also in the 1996 data collection and provided a complete set of information. These students were in years 8, 9 and 10 in 1996 and in years 9, 10 and 11 in 1997.

Table 5. Sample size by rural location for 1996/7 longitudinal cohort.

Year (Grade)	Perth	Small Rural Centre	Other Rural Area	Remote Centre	Other Remote Area	Total Students
9	122	37	101	30	65	355
10	89	43	91	44	44	311
11	75	23	27	25	33	183
Total Students	286	103	219	99	142	849
Schools	4	4	6	3	4	21

METHODOLOGY

Students from these schools were asked to complete a questionnaire, along with a combined mathematics and science test. The student questionnaire consisted of background and socioeconomic questions, along with questions about their rural life.

In this questionnaire, students completed the *Self-Concept* scales consisted of a set of statements to which the student responded on a five point measure, from False, Mostly False, Neither False nor True, Mostly True to True (coded 1 to 5). Each student was also asked about their *Classroom Learning Environment* and these scales were also estimated for reliability (6 scales).

The 97 Science/Mathematics teachers participating from each of the 21 schools completed a Teacher Questionnaire, consisting of the *School Level Environment Questionnaire* (SLEQ), including 8 scales and 56

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items, and a few other background questions. The SLEQ has already been described previously. Teachers mailed their completed questionnaires directly to the research project using a reply-paid envelope.

Confirmatory factor analysis

These student and teacher composite scales consisted of items which were categorical, not continuous. Additionally, these items varied in their loadings which indicated that Confirmatory Factor Analysis was crucial to the effective construction of the composite scale. When the observed variables (items) are non-normal and non-continuous, the use of product-moment correlations can lead to large negative biases in their estimates (Jöreskog, 1990; Carroll, 1961). It is therefore a significant feature of this study that Structural Equation Modelling techniques (WLS) were used which assume that the observed variables are measured on an interval scale with non-normal distributions. Jöreskog (1994, p. 383) observed that ordinal variables represent a set of ordered categories, such as the five-category Likert scale, which need to be treated differently:

> "It is common practice to treat scores 1, 2, 3, 4, 5, representing the ordered categories of an ordinal variable as numbers on an interval scale and use a covariance matrix computed in the usual way to estimate a structural equation model. What is so bad with this is not so much that the distribution is non-normal; more importantly the distribution is not continuous: there are only four distinct values in the distribution."

The Weighted Least Squares (WLS) method available in LISREL 8 was developed to assist with the analysis of non-normally distributed variables by providing an appropriate weight matrix, correct parameter estimates, standard errors and a fit statistic. "The weight matrix required for such an analysis is the inverse of the estimated asymptotic covariance matrix W of the polychoric and polyserial correlations" (Jöreskog & Sörbom, 1993, p. 45).

In this study, the polychoric correlation matrix and asymptotic variance-covariance matrix were produced using Weighted Least Squares (WLS) PRELIS, which was then analysed using LISREL. This procedure was used to calculate each composite scale, assuming the one-factor congeneric measurement model. The one-factor congeneric measurement model (Jöreskog, 1971) was used in order to construct a set of factor score regression weights using LISREL (Jöreskog & Sörbom, 1996). Fitting a congeneric measurement model allows for differences in the contribution each individual measure contributes to the overall composite scale (Fleishman & Benson, 1987).

The estimated composite score ξ_n for each person was calculated by multiplying each item x_i by its factor score regression weight. The factor score regression weights are produced by LISREL output when a one-factor congeneric measurement model is estimated for a set of items.

Reliability

That reliability is the consistency of measurement is a concept which has developed from classical test theory and assumes that a single true score underlies a measure (Bollen, 1989, p. 221). While Cronbach's (1951) alpha coefficient is the most popular reliability coefficient in social science research, it has the weakness of underestimating reliability for congeneric measures. Bollen recommends using the Coefficient of Determination R^2_{xx}, as a viable alternative for measuring reliability, where structural equations are being used. This is the measure of the proportion of variance in a measure which is explained by the variables that directly effect x_i.

Table 6. Means, reliabilities and ANOVA F-test for student and teacher/school variables by location for 1996/7 cohort.

Variable	Total Mean	SD	Perth	Small Rural Centre	Other Rural Area	Remote Centre	Other Remote Area	ANOVA F test (Sig)	Cronbach's Alpha Reliability	Coefficient of Determination
Location of School (code)			1	2	3	4	5			
Gender	.47	.50	.45	.50	.43	.43	.54			
Aboriginality	.04	.19	.02	.02	.03	.10	.05			
ESB	.96	.18	.93	.96	.99	.95	.99			
Student Classroom Learning Environment										
Student Cohesiveness	3.57	.34	3.54	3.68	3.66	[illegible]	3.46	13.04**	.857	.937
Teacher Support	3.45	.36	3.46	3.67	3.38	3.44	3.44	15.18**	.869	.952
Involvement/Negotiation	3.53	.28	3.49	3.65	3.58	3.39	3.57	16.65**	.774	.932
Task Orientation	3.50	.29	3.53	3.66	3.48	3.30	3.47	23.01**	.967	.929
Cooperation	3.48	.31	3.48	3.67	3.56	3.33	3.35	29.73**	.970	.949
School Learning Environment										
Affiliation	4.05	.43	3.91	4.15	4.09	4.18	4.08	12.54**	.890	.961
Empowerment	3.27	.42	3.52	3.50	3.04	2.97	3.16	92.08**	.740	.853
Innovation	3.43	.34	3.51	3.77	3.04	3.53	3.57	224.47**	.802	.918
Mission	3.44	.37	3.29	3.68	3.31	3.34	3.84	108.51**	.766	.926
Professional Interest	3.66	.42	3.76	3.80	3.38	3.78	3.68	40.37**	.905	.926
Resources	3.46	.38	3.46	3.50	3.51	2.97	3.67	69.45**	.816	.890
Student Support	3.87	.37	3.76	4.06	3.94	3.42	4.15	103.40**	.867	.986
Work Pressure	3.93	.27	3.92	4.04	3.84	4.07	3.91	19.06**	.824	.933
Student Self-Concept										
General Self-Concept	4.12	.74	4.20	4.18	4.11	4.01	4.01	2.32	.839	.946
Academic Self-Concept	3.90	.78	3.99	4.04	3.90	3.75	3.68	5.75**	.772	.945
Student Achievement										
Science Achievement 1997	1.06	1.25	.91	1.45	1.42	.73	.72	12.88**	1.001	
Maths Achievement 1997	1.20	1.31	1.19	1.39	1.58	1.02	.63	12.74**	1.001	
Socioeconomic Status	2.98	1.02	2.92	2.92	3.12	3.10	2.84	2.48*	.889	
Teacher Self-Concept										
General Self-Concept	4.44	.26	4.54	4.53	4.22	4.55	4.45	75.89**	.821	.931
Academic Self-Concept	4.08	.27	4.12	4.21	4.00	4.11	4.01	15.54**	.728	.977
Teacher Morale										

Note: * indicates that the F test was significant at $p < 0.05$ level
** indicates that the F test was significant at $p < 0.01$ level

t is the Infit Mean Square for the Achievement Tests provided by the QUEST software using the Rasch modelling technique. 1.00 indicates that the achievement measure is highly reliable

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For the purposes of this research, the Coefficient of Determination was used as the measure of reliability. The method used was based upon Werts, Rock, Linn and Jöreskog (1978).

While Cronbach's Alpha Reliability coefficient is provided in Table 6, the Coefficient of Determination is given in order to show the true reliability. All composite scales given in Table 6 were prepared using the confirmatory factor analysis described above with factor score regression weights, except for Socioeconomic Status which was not weighted due to the different metrics used. Instead, SES was calculated with unit weighting and the appropriate reliability coefficient used.

The achievement test scores were constructed using Rasch modelling procedures and therefore the Infit Mean Square is provided as an alternative test of reliability. Further, the achievement test scores were kept separate by Year due to the test being different for each year, although of equal ability requirement.

Comparisons of Schools by Location

Once the scales were constructed and checked for reliability, they were compared by the five location categories and significant differences were found for all scales, except general self-concept (see Table 6). The Analysis of Variance results showed that there were significant differences between schools from the urban and rural locations.

All scales tended to be lower for students from Remote Centres, however it was suspected that these variations may be related to socioeconomic status. Teachers perceived that students were more supportive in the metropolitan schools, students perceived that teachers and their own peers were more supportive in the country schools. While General Self-Concept of students was equal across the five locations, students from remote locations had significantly lower Academic Self-Concept.

Students in country schools (rural and remote) appeared to be more satisfied with their schools. They felt that teachers were more supportive, friends were more supportive and generally felt safer. Science and Mathematics Achievement scores were not comparable due to the lack of a prior achievement measure in this stage of the study. That is, while there were differences in achievement between students from rural and urban locations, the scores were more a reflection of the students' ability than a random selection.

The numbers of Aboriginal students in this study was higher in the remote centres and areas, leading to some confounding of results. Therefore, a further analysis was conducted combining all of these possible effects into a single multilevel model of analysis.

The Three-Level Multilevel Linear Model: Background

While there appeared to be differences between rural, remote and metropolitan schools in the initial analyses, some of these differences could be due to socioeconomic factors rather than rurality. Further, there could be other school or teacher effects which contribute towards explaining these differences. Therefore, it is not enough to simply examine location differences and report these individually. In order to investigate the influence of location and rurality in explaining differences in student achievement, a multilevel linear model of analysis was employed. In this case, a three-level model was used where student, class and school comprised the three levels of analysis.

Traditional linear models on which most researchers have relied upon, require the assumption that errors are independent, yet most subjects are 'nested' within classrooms, schools, districts, states and countries so that responses within groups are group dependent. To ignore the nested structure of this type of data ultimately will give rise to problems of aggregation bias (within-group homogeneity) and imprecision (Burstein, 1980; Raudenbush, 1988).

The Multilevel Linear Model provides an integrated strategy for handling problems such as aggregation bias in standard error estimates and erroneous probability values in hypothesis testing of school effects. For this study, MLn was chosen as the software program appropriate to study school and student effects relating to student outcomes. Research on school effects has previously been conducted with a set of data analysed at the individual student level, with the assumption that classrooms and schools affect students equally. However, when the effects vary among individuals and their contexts, this type of statistical analysis can be misleading (Bryk & Raudenbush, 1987). Ordinary least squares analysis provides information about the total variance, but can only break this total variance into the between- and within-school effects. The between-school effect may be influenced by school level variables, such as the affluence of the school. This study endeavoured to explain variations in student outcomes by first decomposing observed relationships

into between- and within-school components.

Previous studies have shown clearly that educational researchers need to account for the inherent multilevel structure of data collected from schools and this literature includes Mason et al. (1983), Bosker and Scheerens (1989), Bryk and Raudenbush (1986, 1989, 1992) and Goldstein (1984, 1987, 1995).

The Three-Level Multilevel Linear Model: The Variables

The response variables for this analysis were Science and Mathematics Achievement (two 18 item scales). There were six different types of variables used in the multilevel analysis (shown below). While some analyses described earlier suggested that rural schools may be disadvantaged, the findings were unclear. The multilevel analyses combined all of the possible explanatory variables under investigation here and revealed how they combine to influence student attitudes.

Science Achievement	A student science achievement test consisting of 18 multiple choice response format test items selected from the Third International Mathematics and Science Study (TIMSS) and total score estimated using the Rasch Model.
Math Achievement	A student mathematics achievement test consisting of 18 multiple choice response format test items selected from the Third International Mathematics and Science Study (TIMSS) and total score estimated using the Rasch Model.
Ach96	Science and mathematics achievement scores from 1996 estimated using the Rasch Model.
SES	Socioeconomic Status of the students consisting of mother and father's occupations and education (continuous and standardized).
Gender	1 = males; 0 = females
Aboriginal	1 = Aboriginal; 0 = non-Aboriginal
English Speaking Background	1 = English speaking background 0 = non-English speaking background
Self-Concept	Two measures of the students' and teachers' self-concept: Academic Self-Concept and General Self-Concept (continuous and standardized).
SLEQ Scales	Eight measures of the teachers' perceptions of the school environment aggregated to the school level (continuous and standardized).
CLE Scales	Six measures of the students' perceptions of the classroom learning environment kept at the student level (continuous and standardized).
Location	A five category measure described previously: Metropolitan Perth, Small Rural Centre, Other Rural Areas, Remote Centre and Other Remote Areas (1 to 5).

The Three-Level Multilevel Linear Model: Unconditional Statistical Model

In this study, the use of the multilevel linear model involved the single cross-section of data with a three-level structure consisting of students (Level 1) nested within classes (Level 2) nested within schools (Level 3).

The simplest model was used first, that is, the fully unconditional model with no predictor variables specified. The outcome measures, science and mathematics achievement, were free to vary across three different levels of analysis: student, class and school. This model is described below in Equations 1, 2 and 3.

Student-Level Model. Science/Mathematics Achievement for each student was estimated as a function of the class average plus random error:

$$Ach_{ijk} = \pi_{0jk} + e_{ijk} \qquad \text{Equation 1}$$

where

Ach_{ijk} represents the Science/Mathematics Achievement of each student i in class j and school k.

π_{0jk} represents the class mean Science/Mathematics achievement of class j in school k.

e_{ijk} represents the random error of student i in class j and school k

$i = 1, 2, 3, \ldots, n_{jk}$ students in class j and school k.

$j = 1,2, \ldots J_k$ classes within school k,

$k = 1, \ldots, K$ schools.

Class-Level Model. Science/Mathematics achievement classroom mean varies as a function of the school mean plus random error:

$$\pi_{0jk} = \beta_{00k} + r_{0jk} \qquad \text{Equation 2}$$

where

β_{00k} represents the mean Science/Mathematics achievement in school k.

r_{0jk} represents the random error of class j within school k

School-Level Model. Science/Mathematics school mean achievement varies randomly around a grand mean for all schools.

$$\beta_{00k} = \gamma_{000} + \mu_{00k} \qquad \text{Equation 3}$$

where

γ_{000} represents the grand mean Science/Mathematics achievement for all schools.

μ_{00k} represents the random school effect, the deviation of school k's mean from the grand mean.

This three-level model partitions the total variability in the outcome measure, Science/Mathematics achievement, into its three components: students within classes (σ^2), classes within schools (τ_π) and between schools (τ_β).

The Three-Level Multilevel Linear Model: Contextual/Student Background Statistical Model

In order to investigate the effect of the student background and context variables upon student achievement in science and mathematics, this model was estimated first using student Socioeconomic Status (SES), Sex of student (Gender), Aboriginality (Ab) of student, English speaking background (Eng) of student For the purposes of this model, the intercept was allowed to vary across classes and schools. That is, mean achievement varied between classes due to classroom effects and schools due to school effects.

In the equation presented below, Ach_{ijk} is the Science/Mathematics achievement of student *i* in class *j* and in school *k*. This is the student level equation. There is one random equation and six fixed effects equations presented next, with the mean achievement π_{0jk} allowed to vary between classes. This is the classroom level equation. Finally, there is one random equation at the school level, where the grand mean achievement β_{00k} is allowed to vary across schools. This is the school level equation. Together these separate equations make up the statistical model used to estimate the effects of context and student background variables on student achievement. Two separate analyses were conducted for science and mathematics achievement.

$$Ach_{ijk} = \pi_{0jk} + \pi_{1jk}(SES_{ijk}) + \pi_{2jk}(Gender_{ijk}) + \pi_{3jk}(Ab_{ijk}) +$$

$$\pi_{4jk}(ESB_{ijk}) + \pi_{5jk}(ASC_{ijk}) + \pi_{6jk}(Grade_{ijk}) + \pi_{7jk}(Ach96_{ijk}) + e_{ijk}$$

$$\pi_{0jk} = \beta_{00k} + r_{0jk} \qquad \pi_{4jk} = \beta_{400}$$

$$\pi_{1jk} = \beta_{100} \qquad \pi_{5jk} = \beta_{500}$$

$$\pi_{2jk} = \beta_{200} \qquad \pi_{6jk} = \beta_{600}$$

$$\pi_{3jk} = \beta_{300} \qquad \pi_{7jk} = \beta_{700}$$

$$\beta_{00k} = \gamma_{000} + \mu_{00k}$$

Equation 4

The Three-Level Multilevel Linear Model: Three Statistical Models

Upon estimation of the contextual/student background model, three further conditional models were estimated in order to investigate the effects of the

- Location of the School
- Classroom Learning Environment
- School Level Environment

RESULTS

The Three-Level Multilevel Linear Model: Student Achievement and Contextual/Background Effects

Firstly, the variation in student science and mathematics achievement was decomposed at the three levels as shown in Table 7. Most of the variation in science achievement was found to be at the student level (66.65%), with 33.43% variation between classes and .91% variation between schools. Similarly, the variation in mathematics achievement was mostly between students, with 58.82% of the total variance between students, 41.09% between classes and 0% between schools.

Table 7. Variance components analyses for three-level model for science and mathematics achievement.

Level of Analysis	Parameter	Science Achievement Estimate (s.e.)		Mathematics Achievement Estimate (s.e.)	
Fixed Model	Constant	-.089 (0.072)		-.130 (0.075)	
Random Model	**Parameter**	**Variance Estimate (s.e.)**	**Percentage of Total Variance**	**Variance Estimate (s.e.)**	**Percentage of Total Variance**
School	Constant	0.009 (0.032)	.91 %	0.001 (0.035)	.00 %
Class	Constant	0.329 (0.069)	33.43 %	0.424 (0.084)	41.09 %
Student	Constant	0.646 (0.033)	66.65 %	0.607 (0.031)	58.82 %
Total		.984	100.00 %	1.032	100.00 %

There were variations in school average achievement for both science and mathematics, however these were negligible when student background, grade, average SES and school location were added to the model. The distribution of achievement is demonstrated in Figures 2 and 3. Very little variation between schools was found.

Secondly, five student level variables were included in this three–level model: Grade, student socioeconomic status (SES), Gender, Aboriginality, English Speaking Background and Academic Self-Concept. The SES effect was weak and positive (and significant being greater than two standard errors), while the gender effect was strong and positive (significant). That is, boys were outperforming girls in both mathematics and science. While the effect of being Aboriginal or Torres Strait Islander was strong and negative, the effect of speaking English in the home most of the time was positive on achievement. These effects, were both strong and accounted for a significant proportion of variation in student achievement. The effect of Grade, SES, Gender, Aboriginality, English Speaking Background and Academic Self-Concept on science achievement explained 20.22% of the total residual variance for science achievement and 37.98% for mathematics achievement (Table 8).

Although there was no variance left at the school level to explain, the distribution of teacher/class level residual effects was investigated in two histograms for science and maths. It was clear from the distributions that some classes had high achievement and some were low, even when accounting for previous achievement (Figures 4 and 5). That is average achievement varied across classrooms more than across schools, with the result that some of this variation may have been attributable to variations in teacher characteristics, peer effects or the classroom learning environment.

In the analysis of the multilevel model, the effect of the Classroom Learning Environment was measured, along with the School Level Environment. However, neither of these appeared to contribute significantly towards explaining differences in student achievement. Overall, the Classroom Learning Environment explained 2.54% and 3.29% of the variance in science and maths achievement, respectively (see Table 8). Further, the School Level Environment scales explained little variation in science and maths achievement (see Table 8).

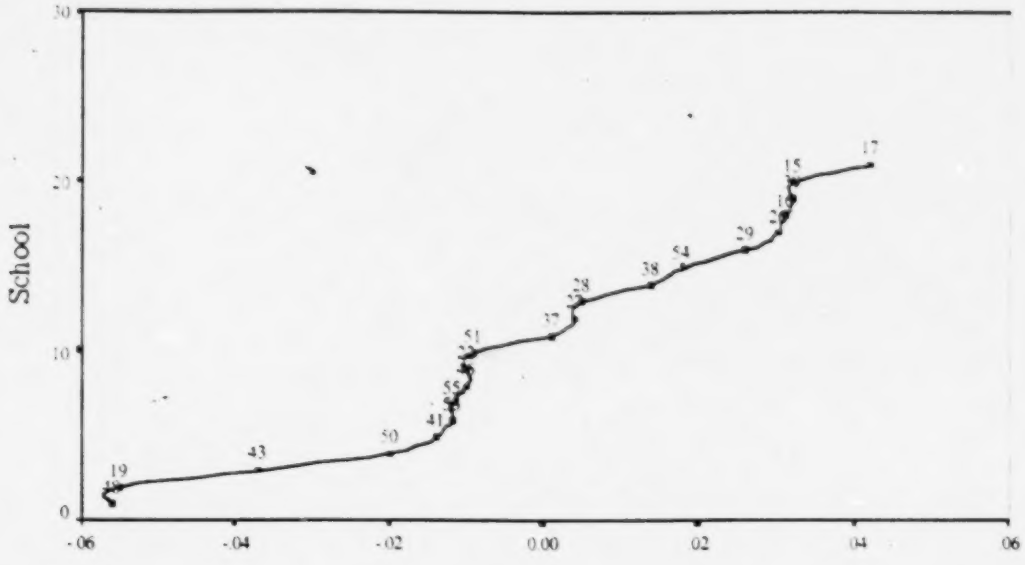

Figure 2. Distribution of School Average Science Achievement

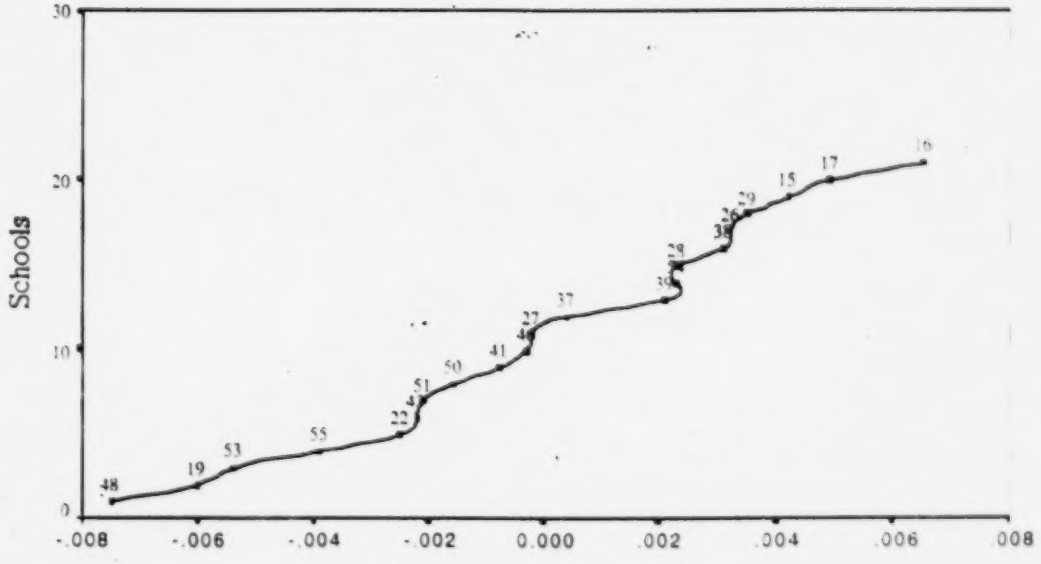

Figure 3. Distribution of School Average Maths Achievement

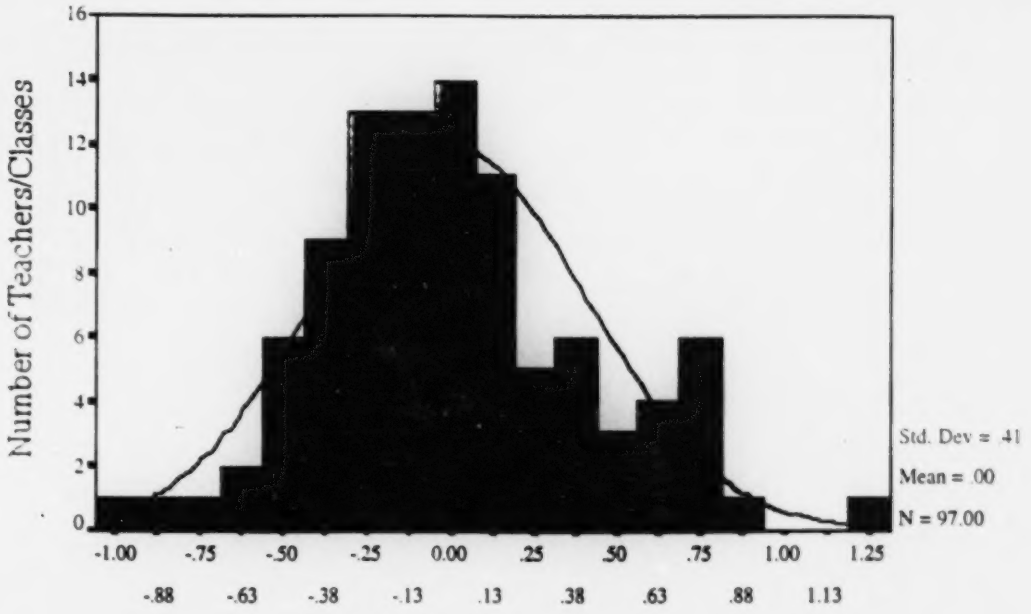

Figure 4. Distribution of Class Average Science Achievement after Controlling for Student Background

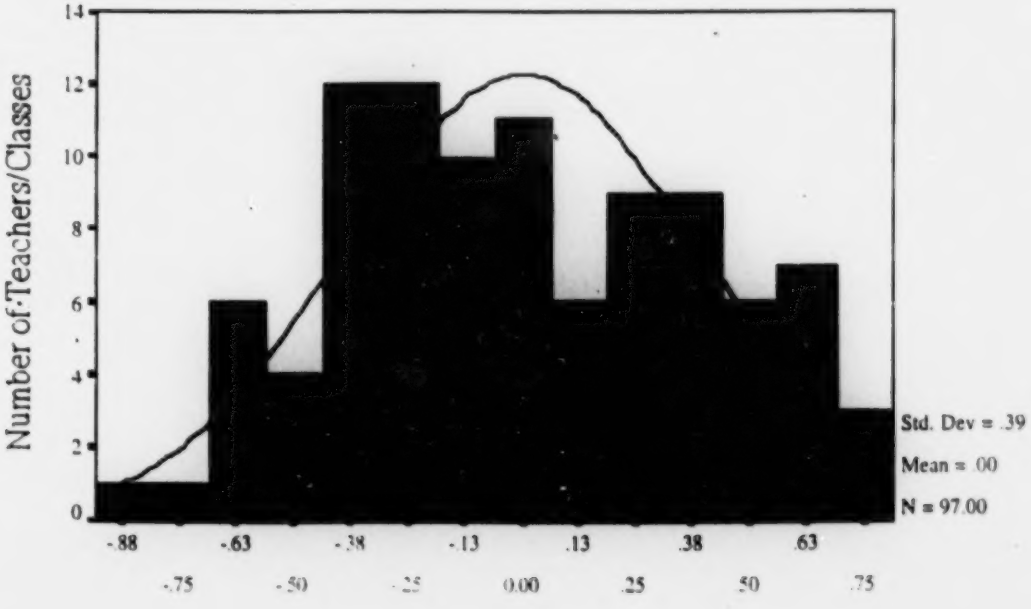

Figure 5. Distribution of Class Average Math Achievement after Controlling for Student Background

Table 8. Effect of Location of School, Grade and Average Socioeconomic Status on science and mathematics achievement after controlling for student background variables.

		Science Achievement		Mathematics Achievement	
Level of Analysis	**Parameter**	**Estimate (s.e.)**		**Estimate (s.e.)**	
Fixed Model	Constant	3.281 (.779)		3.712 (.719)	
	SES	.000 (.028)		.042 (.025)	
	Gender	.069 (.055)		-.060 (.048)	
	Aboriginal	-.302 (.147)		-.215 (.131)	
	English Spk Bk.	.150 (.149)		.447 (.132)	
	Academic Self-Concept	.129 (.029)		.180 (.026)	
	Grade	-.350 (.076)		-.418 (.070)	
	Ach96	.307 (.032)		.424 (.030)	
	Location	-.019 (.040)		-.031 (.038)	
Student Background Variables + Grade					
Random Model		**Variance Estimate**	**Variance Explained by Student Background**	**Variance Estimate**	**Variance Explained by Student Background**
School	Constant	0.000 (0.000)	.91%	0.000 (0.000)	.00%
Class	Constant	0.233 (0.046)	9.76%	0.211 (0.041)	20.64%
Student	Constant	0.552 (0.028)	9.55%	0.429 (0.022)	17.25%
Total		0.785	20.22%	0.640	37.98%
Student Background Variables, Grade + Location					
Random Model		**Variance Estimate**	**Variance Explained by Location**	**Variance Estimate**	**Variance Explained by Location**
School	Constant	0.000 (0.000)	.00%	0.000 (0.000)	.00%
Class	Constant	0.233 (0.046)	.00%	0.211 (0.041)	.00%
Student	Constant	0.552 (0.028)	.00%	0.429 (0.022)	.00%
Total		0.785	.00%	0.640	.00%
Student Background Variables, Grade, Location of School + Classroom Learning Environment Scales					
Random Model		**Variance Estimate**	**Variance Explained by CLE**	**Variance Estimate**	**Variance Explained by CLE**
School	Constant	0.000 (0.000)	.00%	0.000 (0.000)	.00%
Class	Constant	0.209 (0.043)	2.44%	0.178 (0.035)	3.20%
Student	Constant	0.551 (0.028)	.00%	0.428 (0.022)	.00%
Total		0.760	2.54%	0.606	3.29%
Student Background Variables, Grade, Location of School, CLE + School Level Environment Scales					
Random Model		**Variance Estimate**	**Variance Explained by SLEQ**	**Variance Estimate**	**Variance Explained by SLEQ**
School	Constant	0.000 (0.000)	.00%	0.000 (0.000)	.00%
Class	Constant	0.200 (0.041)	4.1%	0.176 (0.035)	.00%
Student	Constant	0.551 (0.028)	.00%	0.429 (0.022)	.00%
Total		0.751	1.2%	0.605	.00%

Features of Effective Schools

Comparing effective and ineffective schools was then evaluated using another significant measure: Teacher Morale. This is an exceeding useful tool, yet simple to gather from a range of teachers and borrowed from research conducted by Peter Hill and Ken Rowe in Melbourne, Victoria.

In the first instance, Teacher Morale distribution was analysed using a simple histogram (Figure 6). The 29 schools were widely distributed and it was also noted that this distribution was not correlated with achievement (Figure 7). That is, some schools with high Teacher Morale had students with low achievement (and vice versa).

Next, schools with high Teacher Morale were categorized as being effective and schools with low Teacher Morale were categorized as being ineffective (a dichotomous category) and then some comparisons made using simple histograms. It was interesting to see how Teacher Morale related to other environment and psychological measures. These comparisons may be summarized as follows:

- effective schools (high teacher morale) contained students and teachers with high self-esteem – the largest gap was for teachers' academic self-concept which was higher in the effective schools (Figure 8)
- effective schools had more positive classroom learning environments – the gap was greatest for the students' perceptions of teacher supportiveness (Figure 9)
- effective schools had a more positive school environment – in particular, the school mission was more clearly identified in the effective schools (Figure 10)

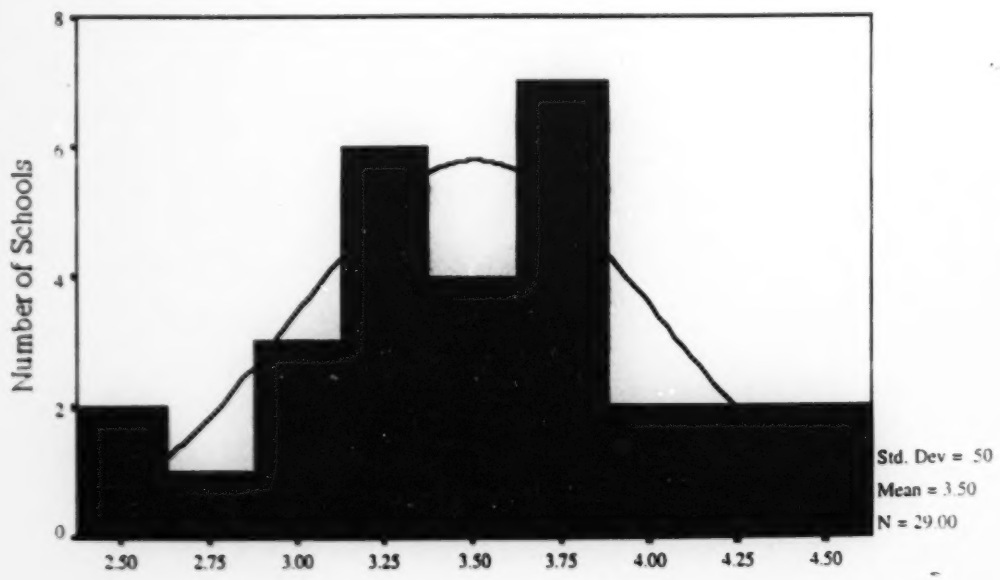

Figure 6. Distribution of School Average Teacher Morale

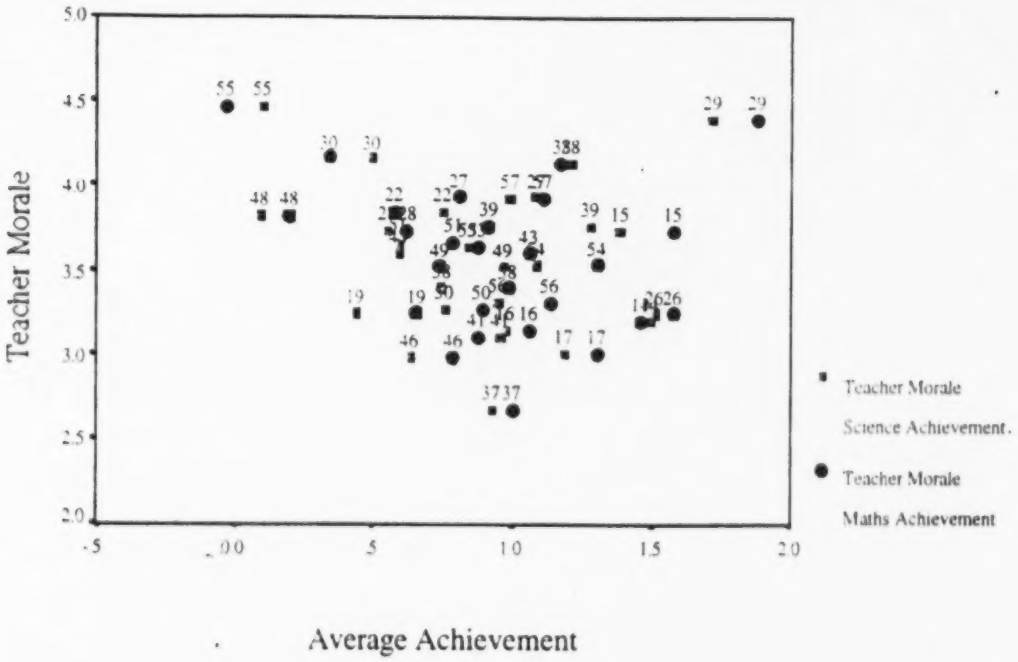

Figure 7. Scattergram of Teacher Morale and Stude[illegible]evement

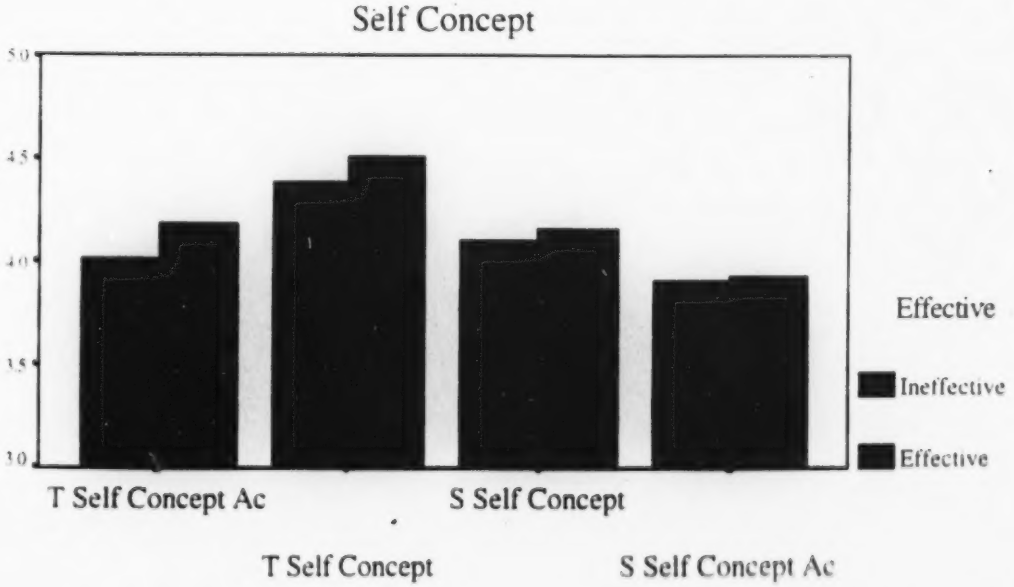

Figure 8. Comparison of Teacher (T) and Student (S) Self-Concept (Academic and General) for Ineffective and Effective Schools

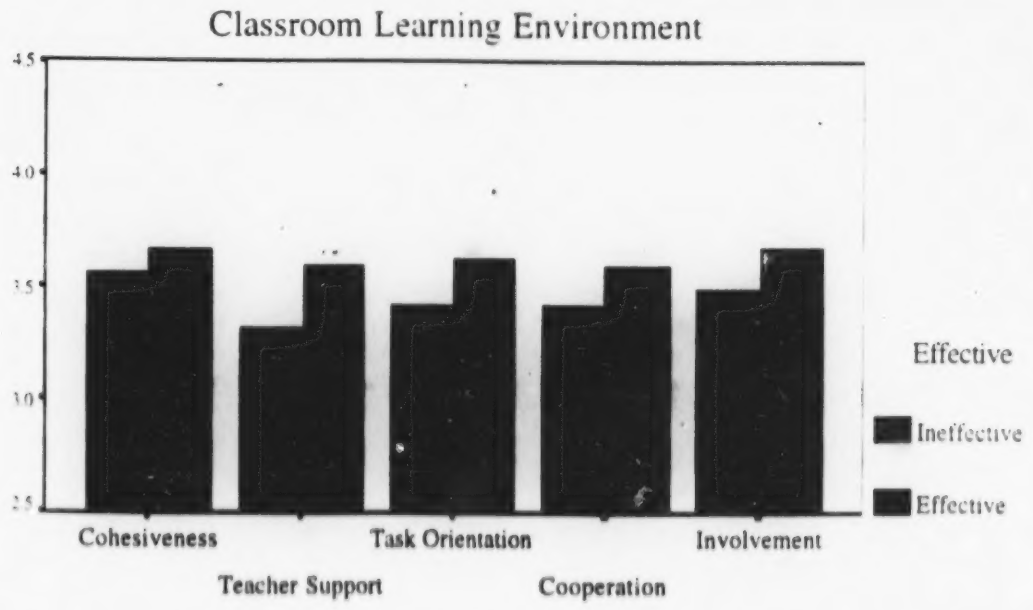

Figure 9. Comparison of Classroom Learning Environment Scales for Ineffective and Effective Schools

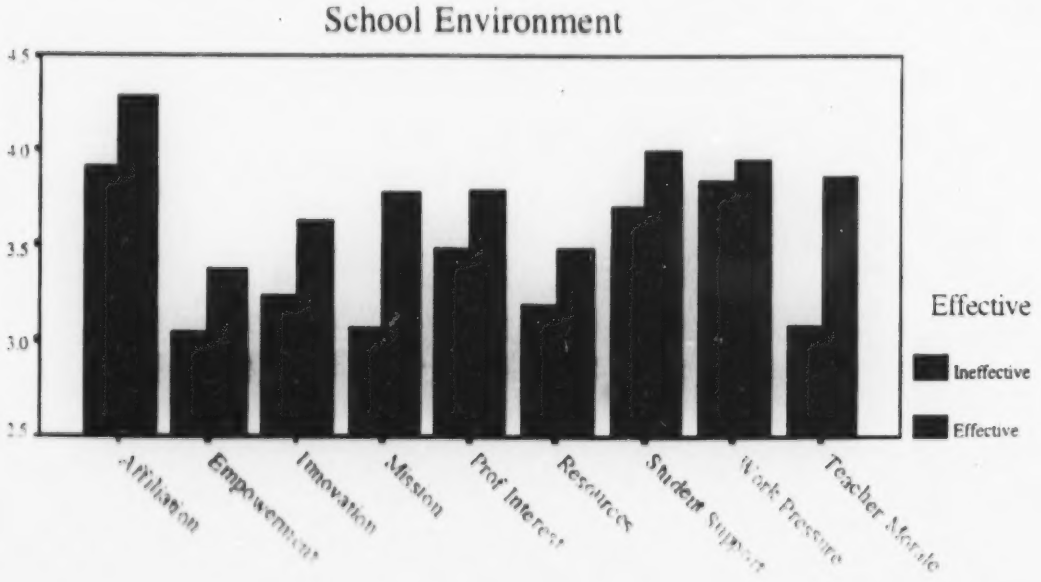

Figure 10. Comparison of School Environment Scales for Ineffective and Effective Schools

Features of Effective Teachers

In this study of effective schools, a greater degree of teacher effectiveness has been a recurring theme. While the teacher effects have not equated to an associated higher achievement, the relationship between teacher morale and other school and classroom environment variables was demonstrated. Further, there is a clear need to investigate the "Effective Teachers" in a more direct way: classroom observations, interviews and of particular interest is the measure of "Academic Self-Concept" or Teacher Efficacy.

DISCUSSION

In recent years, researchers are looking at alternative approaches to defining school effectiveness or educational effectiveness.

One way is to say that the school is effective in terms of high ***achievement***, after controlling for student background and previous achievement. However this study demonstrated that there were no residual school level differences in science and mathematics achievement, once student background and other influences were controlled for. Further, there were no rural/urban differences in achievement after controlling for student background and previous achievement. That is, rural and urban schools contributed equally towards improvement in student achievement. That is, student achievement was mostly associated with teacher and student variables, with little influence by the school.

Another approach to effective education is to examine the effect of school and classroom on ***teacher morale***. This study took a general comparative methodology to examine teacher morale over the 21 schools under investigation and found that there were significant differences between schools with high and low teacher morale. Generally, schools with high teacher morale consisted of students and teachers with higher self-esteem, higher self-efficacy, a more positive classroom learning environment and a more positive school environment.

As this study unfolded and the statistical analyses proceeded, the measures of effectiveness became more open to question. Schools which add value to student achievement were difficult to locate as the variability in student achievement was minimal, compared to the variability at the classroom level. It would be useful to follow a class of students and a teacher over time, however, following classrooms over time can only be done at the beginning and end of a school year, as students scatter over a range of other classrooms in a succession of years (and often to other schools). It would certainly be useful to follow a number of effective teachers over time, paying particular attention to psychological effects such as ***teacher efficacy***, self-esteem and teaching strategies. Selecting such teachers may be difficult and entail the use of a variety of research techniques such as naturalistic inquiry. Further, close scrutiny of teachers involves a great deal of time, personnel and financial resources.

CONCLUSION

In research on effective schools, assumptions are often made that an effective school will produce students of higher achievement, a greater sense of satisfaction with the school, friends and teachers, and a more positive perception of their classroom. Further to this, the teachers will feel more satisfied with their leadership and their workplace.

However, variability between schools in terms of student achievement was minimal once adjustments were made for student background effects. This paper clearly demonstrates the folly of focusing research on achievement, without due regard to other measures such as staff morale and teacher efficacy.

> The next stage in the analysis of the WASES data collection is to model those factors which enhance staff morale, rather than just those factors which enhance achievement.

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